Global assessment of antibiotics in river systems using a high-resolution contaminant fate model

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Antibiotics in Global Rivers

• Misuse and overuse of antibiotics

• They reach the river systems through the waste system

• Drug resistant bacteria in rivers
Our goal

Estimate concentrations of antibiotics in any river in the world
HydroROUT

- Simulates transport processes in rivers
- High spatial resolution (500m)
- Contaminant fate module applied in Canada, India and China (Grill et al., 2016; 2018; Shakya, 2017)
- Wastewater Treatment Plants

Simulated azithromycin concentrations in rivers under low flow conditions. (Grill et al., 2016)
Global wastewater treatment plants database

58,502 points connected to the river network

Including population served, wastewater discharged and level of treatment

Ehalt Macedo et al., 2021 (in prep)
Contaminant Fate Module

• Steady-state plug flow model

• Amount of contaminant:
  – Population data from gridded global datasets
  – Consumption data

(Shakya, 2017)
Domestic consumption of antibiotics

Center For Disease Dynamics, Economics & Policy
Uncertain parameters

- Metabolism rate
- Direct discharge coefficient (ddc) for untreated populations
- WWTP removal
- Environmental river decay
- Lake removal

- Scenarios can be created to analyze the effects of these parameters on the results.
Application: Sulfamethoxazole

- 217 measurements
- Blue points – baseline scenario
- Red points – Maximum concentration (no removal at all)
- Error bars – Worst- and best-case scenarios based on literature

SMX (ng/L) Average discharge

\[ R^2 = 0.6532 \]
Utility of the model

- Identify **hot-spots** of concentrations, focused field studies

- **Screening methods** for new guidelines for pharmaceutical market or disposal

- Set appropriate **wastewater treatment standards** for specific regions – expensive treatment only where needed

- Drive the development and **deployment of new technologies** in potential global markets
Summary

• First estimates of antibiotics in the global river system at high spatial resolution
• New dataset with explicit location of wastewater treatment plants
• First-time validation using global measurements
• Next step: test for other antibiotics, analyze uncertain parameters
• Approach can later be used for other emerging contaminants
References


